Bridge Inspection and Repair

Liam Duffy
Engineering Inspector
National Roads Authority, Ireland

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NRA
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An tÚdarás um Bóithre Náisiúnta

Overview

- Introduction to NRA Bridge Management
- Inspection Types
- Bridge Defects
- Priority Ranking of Works
- Case Study Ferrycarrig Bridge Strengthening
- Strengthening with Advanced Fibre Composites

Eirspan Bridge Management System

- Introduced 2001 – Inventory gathering & PI of 2200 bridges (Consultants) with span > 2.0m on National Roads
- DANBRO customised for use in Ireland
- 60% Concrete, 25% Stone Masonry
- Routine Maintenance 2003 (Local Authorities)
- Structural Assessments 2003
- Eirspan database available via internet

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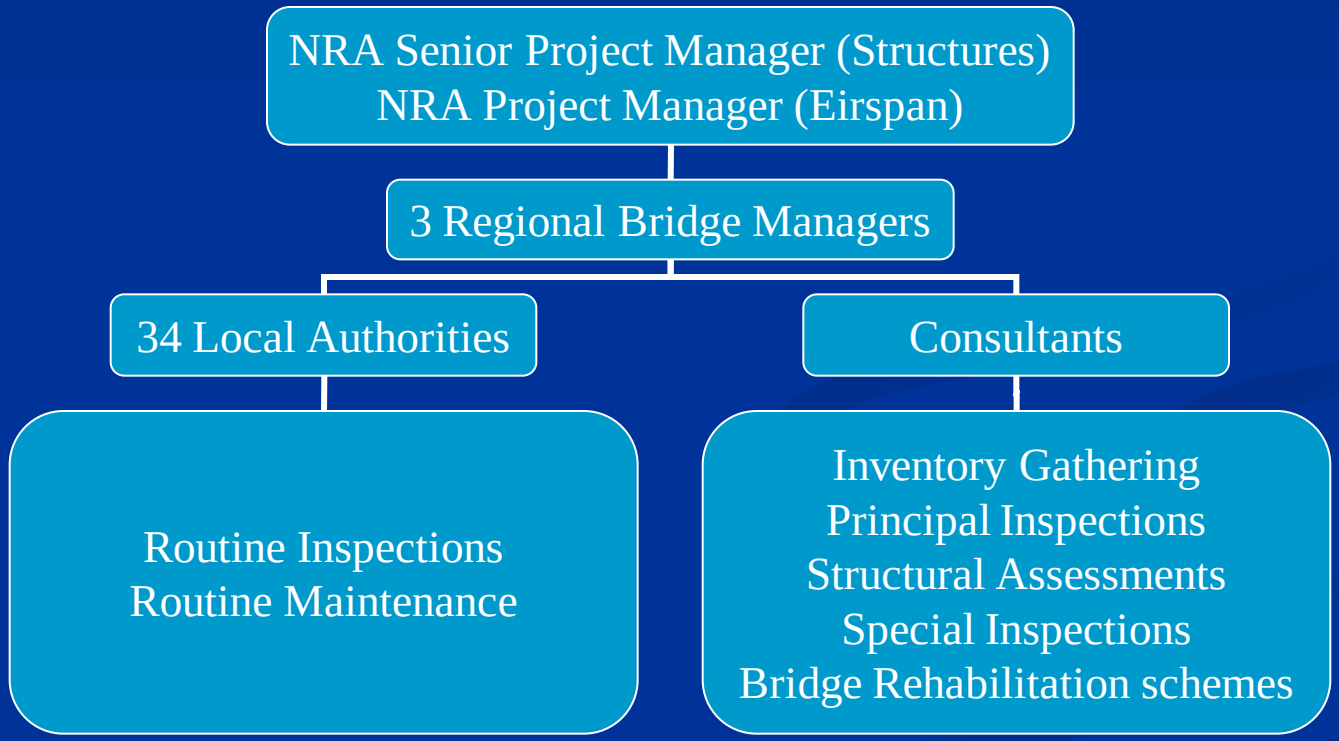
Organisation



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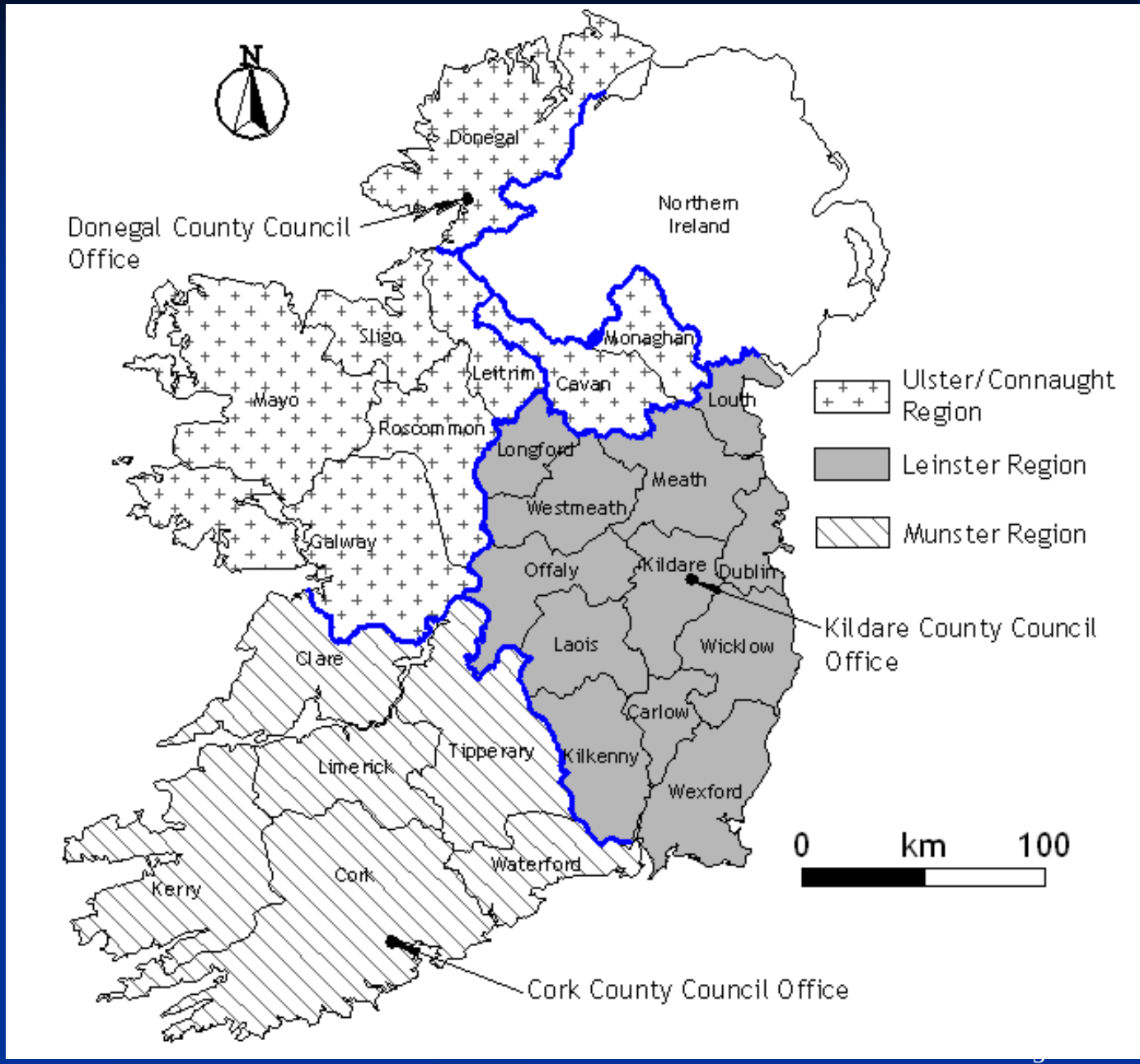
Bridge Management Regions



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News

Minneapolis bridge collapse exposes inspection failures

INADEQUATE INSPECTION regimes failed to expose fundamental and catastrophic structural weaknesses in Minneapolis' devastated I-35W bridge, structural specialists said this week.

The I-35W bridge across the Mississippi river at Minneapolis in Minnesota collapsed without warning at 18:05 local time last Wednesday, killing five and leaving a further eight unaccounted for.

Fatigue in the structure's members is now thought to be the main focus of the investigation by the federal National Transportation Safety Board (NTSB), now in full swing.

It is currently carrying out a detailed finite element analysis of the bridge to help assess possible scenarios.

Minnesota's State Department of Transport (MNDOT) this week confirmed that annual inspections of the bridge relied on "visual inspections with load tests and strain gauges".

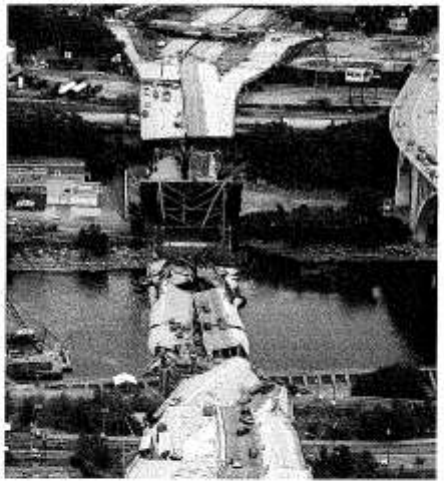
A spokesman said no intrusive tests were carried out.

But according to Mouchel Parkman's structural technical director, Donald Pearson-Kirk visual inspections, such as those carried out on I-35W, would have missed crucial details. He recently led inspection regimes in the United States while with Parsons Brinckerhoff.

"As well as looking, you have to do some testing with some intrusive work, to get a much better picture," said Pearson-Kirk.

"If something looks good, it might not always be so. Similarly, there are times when they look bad but are OK."

He said that with steel bridges, small incisions could be made and strain gauges installed to give engineers a better picture of precisely what was happening inside the structure.



The bridge was a three span steel truss built in 1967. It had longitudinally split a concrete slab deck and was known to have no structural redundancy.

According to a recent report by consultant URS, written in 2006 it had 52 "fracture critical" truss members along its 139.6m span and two 81.1m side spans (see page 6). The report also criticised the inspection regime for the structure.

MNDOT this week confirmed that it would now review its inspection procedure and had engaged consultant Parsons Brinckerhoff to provide advice. It said it would speed up inspections on five similar bridges.

Senior vice president of Chicago-based structural engineering firm CTL Group, Gene Corley, also pointed out that vital evidence must have been missed during inspections.

"Something was not being done," he said, adding that if steel fatigue turned out to be the cause of the collapse "a visual inspection might not have picked this up."

But MNDOT was keen stress that it conducted inspections annually, while federal law required biennial inspections.

The bridge was also undergoing non-structural resurfacing and joint replacement work at the time of the collapse.

Although it was known to have been suffering severe fatigue cracks it is understood this work may have also contributed to the collapse.

Resurfacing work closed two of the four lanes in each direction, but asymmetrically across the bridge while concrete deck sections were replaced.

Bridge expert Mark Whitby said this "would give some interesting stresses in the two trusses – one going one way, the other the other way, and some strain in the cross-members."

Another UK based structural engineer who wished to remain anonymous added: "The deck replacement work may have damaged a critical member of the truss. If there was a fatigue crack, who knows ..they may have taken a piece of deck out above a fatigue crack, put a jack hammer on it and set it off."

He added: "It only needs one member in one truss to go for the whole thing to come down – truss bridges will not generally have any redundancy."

Bennim chairman Mark Raiss, said that the collapse is consistent with fatigue in the steel members.

"Fatigue always starts slowly, but you would expect cracks before anything begins falling down," he said. "Most fatigue failures are preceded by visible cracks, but it is possible the crack length is small or invisible to the naked eye."

Ed Owen in Minneapolis

Types of Inspection

- Routine Inspection
  - Annual inspection by LAs
  - Training workshop for LA engineers
- Principal Inspection
  - Structural inspection by experienced bridge engineers – apply condition index
  - Interval 1-6 years
  - Training workshop for team leaders – manuals with photos

Types of Inspection

- Special Inspection
  - Programme of post-tensioning special inspections
  - Underwater inspections at 6 year intervals
  - Assessment
  - Defect investigation and economic appraisal

Bridge Defects – Expansion Joints

RC Beam Deterioration

RC Bridge Defects

Bridge Defects - Scour

Bridge Defects – Plate Girder Corrosion

Priority Ranking of Repair Work

- Condition Index
- Volume of traffic
- Grouped by repair type and region
- Political influences

Ferrycarrig Bridge Rehabilitation

- 8 span bridge on RC piers
- Cracks up to 1.5mm wide in crossheads
- Insufficient reinforcement in crossheads
- Crossheads strengthened with additional rebar
- Research opportunity – different types of concrete repair for each crosshead
- Remote monitoring of structural health

Ferrycarrig Bridge

Efficiency of Concrete Repairs in a Marine Environment

- Pier crosshead strengthening
- Crosshead concrete repairs:
  - Standard OPC mix
  - OPC mix + increased cover
  - OPC mix + silane
  - OPC mix + mixed-in corrosion inhibitors
  - Ground Granulated Blastfurnace Slag mix
- Remote monitoring of
  - Rate of chloride penetration
  - Rate of corrosion if initiation occurs

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Youghal Bridge Strengthening

Youghal Bridge PTSI

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Plate Bonded CFRP

Plate Bonded CFRP – LA